

**MATERIAL AND EQUIPMENT STANDARD****FOR****SUBMARINE POWER CABLES****WITH INHERENT OPTICAL FIBERS****SECOND EDITION****FEBRUARY 2014**

**FOREWORD**

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS is based on internationally acceptable standards and includes selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

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**GENERAL DEFINITIONS:**

Throughout this Standard the following definitions shall apply.

**COMPANY:**

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

**PURCHASER:**

Means the "Company" where this standard is a part of direct purchaser order by the "Company", and the "Contractor" where this Standard is a part of contract documents.

**VENDOR AND SUPPLIER:**

Refers to firm or person who will supply and/or fabricate the equipment or material.

**CONTRACTOR:**

Refers to the persons, firm or company whose tender has been accepted by the company.

**EXECUTOR:**

Executor is the party which carries out all or part of construction and/or commissioning for the project.

**INSPECTOR:**

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

**SHALL:**

Is used where a provision is mandatory.

**SHOULD:**

Is used where a provision is advisory only.

**WILL:**

Is normally used in connection with the action by the "Company" rather than by a contractor, supplier or vendor.

**MAY:**

Is used where a provision is completely discretionary.

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## 1. SCOPE

**1.1** This standard Specification covers the minimum requirements for the materials, manufacture, inspection, testing and installation of submarine power cables accompanied by inherent optical fiber cables for use in oil, gas and petrochemical industries under the service conditions stated herein.

**1.2** The general requirements are given in this specification. The specific requirements of individual cases will be given in request for quotation and/or purchase order.

### Note 1:

**The standard specification for cables and wires IPS-M-EL-270(0) is withdrawn, and replaced by the following three standard specifications which are issued as latest Revision and amendment .**

- [IPS-M-EL-271](#): Low voltage cables and wires
- [IPS-M-EL-272](#): Medium and high voltage power cables
- [IPS-M-EL-273](#): Submarine power cables with inherent optical fibers

### Note 2:

**This is a revised version of this standard, which is issued as revision (2)-2014. Revision (1)-2003 of the said standard specification is withdrawn.**

## 2. REFERENCES

**2.1** The submarine power cable and the associated optical fiber cables shall be designed, manufactured, inspected and tested in accordance with applicable sections of the latest edition of the following references in particular the recommendations of international electrotechnical commission "IEC" standards.

### IEC (INTERNATIONAL ELECTROTECHNICAL COMMISSION)

IEC 60038	"IEC Standard Voltages"
IEC 60183	"Guide to the Selection of High-Voltage Cables"
IEC 60228	"Conductors of Insulated Cables"
IEC 60502-1	"Power Cables with Extruded Insulation and their Accessories for Rated Voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) - Part 1: Cables for Rated Voltages of 1 kV (Um = 1,2 kV) and 3 kV (Um = 3,6 kV) Consolidated Edition"
IEC 60502-2	"Power Cables with Extruded Insulation and their Accessories for Rated Voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) - Part 2: Cables for rated Voltages from 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV)"
IEC 60502-4	"Power Cables with Extruded Insulation and their Accessories for Rated Voltages from 1 kV (Um= 1,2 kV) up to 30 kV (Um= 36 kV) - Part 4: Test Requirements on Accessories for Cables with Rated Voltages from 6 kV (Um= 7,2 kV) up to 30 kV (Um= 36 kV)"
IEC 60793	"Optical Fibres"
IEC 60794	"Optical Fibre Cables"

- IEC 60811 "Common test Methods for Insulating and Sheathing Materials of Electric Cables (formerly 540)"
- IEC 60874 "Fiber Optic Interconnecting Devices and Passive Components - Connectors for Optical Fibers and Cables"
- IEC 60885-3 "Electrical Test Methods for Electric Cables Part 3: Test Methods for Partial Discharge Measurements on Lengths of Extruded Cables"

**ITU (INTERNATIONAL TELECOMMUNICATION UNION)**

- ITU-T Recommendation G.650-1  
"SERIES G: Transmission Systems and Media, Digital Systems and Networks- Transmission Media and Optical Systems Characteristics – Optical Fibre Cables- Definitions and Test Methods for Linear, Deterministic Attributes of Single-Mode Fibre and Cable"
- ITU-T Recommendation G.650-2  
"SERIES G: Transmission Systems and Media, Digital Systems and Networks- Transmission Media and Optical Systems characteristics – Optical fibre cables- Definitions and Test Methods for Statistical and non-linear related attributes of single-mode fibre and Cable"
- ITU-T Recommendation G.650-3  
"SERIES G: Transmission Systems and Media, Digital systems AND NETWORKS- Transmission media and optical systems characteristics – Optical Fibre Cables- Test Methods for Installed Single-Mode Optical Fibre Cable Links"
- ITU-T Recommendation G. 652  
"SERIES G: Transmission Systems and Media, Digital Systems AND NETWORKS- Transmission Media and Optical Systems Characteristics – Optical Fibre Cables- Characteristics of a Single-Mode Optical Fibre and Cable"

**API (AMERICAN PETROLEUM INSTITUTE)**

- API Specification 17E "Specification for Sub-Sea Umbilicals"

**2.2** Where standards other than IEC are specified, it is understood that the equivalent IEC standard is acceptable.

**2.3** Any deviation from this specification and the above mentioned references shall be clearly mentioned in the vendor's proposal.

**3. SERVICE CONDITION**

The environmental conditions, such as installation depth, air temperature and sea hydrological condition (temperature on sea surface and bottom) used to design the cable, shall be defined in the project particular specification, and/or the data sheet.

**3.1 Water Depth**

Water depth relative to sea level chart datum varies between 30 to 100 meters. The design of the cable shall be based on 100 meters depth.

For design of cables for depth more than 100 meters, the necessary considerations shall be done by vendor and the relevant specification shall be submitted for the company representative approval.

#### **4. VOLTAGE DESIGNATIONS**

**4.1** The voltage levels adopted in the oil, gas and petrochemical industries of Iran are based on the IEC recommendation No. 60038.

**4.2** Power cables are designated for the rated voltages  $U_0/U$  for which the cables are designed.  $U_0$  is the voltage between conductor and earth and  $U$  is the voltage between conductors.

**4.3** The cables designated 0.6/1 kV rms are called low voltage (LV) cables, the cables designated 3.6/6 kV rms are called medium voltage (MV) cables, and the cables designated 6/10 kV, 12/20 kV and 18/30 kV are called high voltage (HV) cables.

**4.4** The available medium voltage power in the Iranian petroleum industry is 3.6/6 kV.

**4.5** The available high voltage power in the Iranian petroleum industry is 6/10 kV and 12/20 kV. For special cases upon the approval of company representative 18/30 kV could be adopted.

**4.6** The highest system voltages according to IEC recommendations is 7.2 kV for 6 kV systems, 12 kV for 10 kV systems, 24 kV for 20 kV systems and 36 kV for 30 kV systems.

**4.7** Unless otherwise indicated in data sheet appendix A, the neutral point of low voltage systems are solidly earthed and the neutral point of medium voltage and high voltage systems are earthed through current limiting resistors.

#### **5. SCOPE OF SUPPLY UNDER THIS SPECIFICATION**

**5.1** Supply of cables, with the lengths, voltages and cross sections as specified in data sheet/s, Appendix A.

**5.2** Supply of all accessories including maintenance tools and test equipment as per article 7 of this specification.

**5.3** Design and supply of packing for shipment.

**5.4** Instruction for installation of cables and relevant accessories.

**5.5** Instruction for repair of cables in future, in case of fault or damage.

**5.6** Transport and installation of cables as a separate proposal, according to article 13 of this specification.

#### **6. CABLE LENGTHS**

**6.1** The total length of the cable/s are specified in the data sheet/s Appendix A. The lengths specified may be revised depending on the sea bottom conditions and the cable laying procedure, which can be proposed by the vendor.

**6.2** As far as technically possible, each cable shall be supplied in one piece without any joint. In cases where, there is more than one piece in each cable length, due to technical constraints, the numbers and lengths of cable pieces shall be stated in the data sheet/s. The numbers of cable pieces in each cable, shall in no case exceed 3 pieces.

**6.3** Necessary numbers of under water splice kits (maximum 2 numbers) plus two extra kits for future use as requested in article 7 of this specification shall be supplied.

## 7. CABLE ACCESSORIES

7.1 Unless otherwise requested, the following cable accessories shall be supplied for each cable length. The accessories except splice kits and pulling heads shall be suitable for installation in classified areas of Zone 2 Group II A, as defined in IEC recommendations.

- 2 Nos. compound filled anchoring systems for mechanical fixing of the armours on the platforms.
- 2 Nos. splitting boxes, to separate power and optical fiber cables.
- 2 Sets of power termination kits.
- 2 Sets of optical fiber cable termination kits.
- 2 Sets of appropriate under water splice kits, for future use, plus the required numbers of splice kits for jointing the cable pieces as stated in the data sheet.
- 2 Nos. pulling heads.
- Necessary inspection equipment and / or maintenance tools, to be quoted separately.

## 8. SUBMARINE CABLE CONSTRUCTION

8.1 The submarine cables shall be designed and manufactured with the following characteristics. The cable supplier shall submit the technical parameters of the cable/s as requested in data sheet/s appendix A.

### 8.2 Conductors

Conductors shall be longitudinally water sealed stranded copper wires, conforming to class 2 of IEC 60228.

### 8.3 Conductor Screen

The conductor screen shall consist of extruded or taped semi-conducting material according to the recommendations of IEC 60502-2.

### 8.4 Insulation

The insulation shall be extruded Cross Linked Polyethylene (XLPE). Ethylene-Propylene Rubber (EPR) insulation may be quoted as an option. The minimum thickness of the insulation shall conform to the recommendations of IEC 60502-2.

### 8.5 Insulation Screen, Non-Metallic Layer

The non-metallic layer of insulation screen shall consist of semiconducting tape or a layer of semiconducting compound extruded directly upon the insulation of each core.

### 8.6 Insulation Screen, Metallic Layer

The metallic layer of insulation screen shall be a layer of tinned copper tape according to the recommendation of IEC 60502-2. Such metallic screen shall be applied over the non-metallic layer of insulation screen with 15% overlap. Other non magnetic metals of manufacturer standard can be proposed. Cable supplier shall indicate the material and the thickness of the metallic screen on the data sheet/s.



### 8.7 Optical Fiber Cables

The submarine cables shall contain interstitial optical fiber cables installed between the power cords. The number of optical fiber cables and the number of optical fibers in each optical fiber cable is specified in the data sheet/s. The optical fibers included in the optical fiber cables shall be suitable for Single Mode Transmission application. Each optical fiber cable shall consist of the following:

- 8.7.1 Steel wire for tensile strength together with suitable protective separator for optical fibers.
- 8.7.2 Optical fibers (Single Mode of Propagation).
- 8.7.3 Optical fiber coating made of double layers of acrylate or equivalent.
- 8.7.4 Siliconic and hydrogen getter or manufacturer standard filling compound.
- 8.7.5 Protective synthetic tapes, polyethylene or equivalent.
- 8.7.6 Copper or steel protective tube for mechanical protection as well as a hermetic barrier versus hydrogen for the optical fibers.
- 8.7.7 Extruded polyethylene sheath or manufacturer standard.

### 8.8 Filler

The interstice material to obtain circular form for the cable including the optical fiber cables shall be suitable material compatible with XLPE insulation.

### 8.9 Binder

The laid up cores together with the optical fiber cables and fillers shall be lapped with suitable manufacturer standard binder tape/s. The tapes shall be non-hygroscopic.

### 8.10 Metallic Sheath

The metallic sheath shall consist of two layers of Bronze tapes or other equivalent metallic tapes, to provide adequate protection against any damage including teredo worm. The material and thickness of the metallic sheath shall be indicated in data sheet/s appendix A.

### 8.11 Bedding

The bedding under the armour shall be extruded or lapped layer/s of PVC or synthetic tape/s of manufacturer standard. The thickness of the bedding shall be according to the recommendations of IEC 60502-2 and shall in no case be less than 1.5 mm.

### 8.12 Armour

The Armour shall be a single layer of galvanized round steel wire together with necessary numbers of cathodic protection zinc wires with a helix of galvanized steel tape. The minimum diameter of the steel wires shall be in accordance with the requirements of IEC 60502-2. The numbers and sizes of the zinc wires, applied between the steel wires, shall be based on protection of steel wires for 25 years. The thickness of the galvanized steel tape shall be at least 0.3 mm.

A single layer of armor is common, but two layers of armoring may be used where there is a significant amount of abrasion or where rock or debris is placed that may fall onto the cable. If two layers are used, the layers may be laid in the same or in opposite directions, depending on the desired coiling characteristics of the cable. The pitch of armor wires may vary depending on the desired bending, stiffness and coiling characteristics of the cable. Round, flat or tape armoring may be used.

Double armor in opposite directions, also called "double-cross armor" is recommended for deep-water projects because it allows building a "torque balanced" cable whose elongation under high tension is reduced to its minimum.

Where cable is installed on rocky seabed, a triple type steelwire armour may also be provided. This case shall be specified in the data sheet/s appendix A.

### **8.13 Serving/Over Sheath**

The serving shall consist of dark black polypropylene yarn or hessian tape, bituminous compound and an over sheath of polypropylene yarn. The over sheath should have adequate thickness to protect the submarine cable during transportation, load out, installation and service. Lime wash shall be applied, when requested in data sheet (only for cables to be kept in storage).

## **9. CABLE TESTS AND INSPECTION**

**9.1** Each cable shall be factory tested and test certificates in three copies shall be submitted to the purchaser.

**9.2** The power cables shall be tested according to the recommendations of IEC 60502-2 and the relevant publications referred to therein.

**9.3** The optical fiber cables shall be tested according to the guide lines of IEC 60794 and ITU-T recommendation G.650.

**9.4** The purchaser may appoint representative/s or third party to witness the factory tests on furnished cables and accessories.

**9.5** The supplier shall inform the date of performing the final factory tests, at least four weeks in advance.

**9.6** The purchaser's appointed inspectors shall be granted the right for inspection at any stage of manufacture, testing and preparation for shipment.

## **10. IDENTIFICATION AND MARKING**

**10.1** Unless otherwise indicated in data sheet/s, the cores of power cables shall be color coded as Red, Yellow and Blue.

**10.2** Colors shall be indelible. If colored material for insulation will not be available, each core shall be wrapped with tapes of appropriate color. The tapes shall be PVC or equivalent and shall cover 100% of the surface of each core.

**10.3** The transportation drums shall be clearly marked to show the following:

- Name of the manufacturer
- Numbers of power cores
- Size of conductors
- Rated voltage
- Type of insulation
- Numbers of optical cables
- Numbers of optical fibers in each optical cable
- Cable length

**10.4** Cable markings showing the cable identification number as appears in data sheet/s will be fixed on the cables (by cable installer). Markings shall be stainless steel or equivalent and shall be applied every 50 meters for the first and last 250 meters and every 500 meters for the remaining length of the cable. These markings shall be permanent and legible to divers and under water video cameras.

**11. DOCUMENTATION**

**11.1** The following documents shall be supplied at the bid stage.

- Detailed constructional specification of cables
- Deviations from this specification if any
- Mechanical and electrical data of the power cables
- The mode of propagation (single mode/multimode) and the wavelength of propagation of the optical fibers
- Reference list of similar supply

**11.2** The following documents shall be supplied with the order.

- Instruction manual for cable loading, transport, laying, jointing and terminations
- Test reports, and test procedures for after installation
- Documentation for all accessories

**12. PACKING FOR SHIPMENT**

**12.1** Packing and preparation for shipment shall be in accordance with manufacturer's standards. The manufacturer shall be the sole responsible for the adequacy of packing and the preparation for shipment.

**12.2** The packing and preparation for shipment shall be adequate to avoid mechanical damage during transport, and handling.

**12.3** Shipping documents with exact description of equipment for custom release shall be supplied.

**13. TRANSPORT AND INSTALLATION**

**13.1** The vendor shall submit a separate proposal on turnkey basis, for undertaking the transportation and installation of the submarine cable/s.

**13.2** The scope of such work includes; loading the cables to the appropriate vessel, transportation of the cables to the site, cables route surveys, cables marking and installation, jointings if necessary, terminations and field testing, according to IEC recommendations.

**13.3** The proposal shall include the supply of all necessary installation accessories such as J-tubes, fixings, and necessary numbers of 25 meters length bend restrict protection duct, to protect the cables on sea bed at each riser entry. These accessories are in addition to the cable accessories specified in section 7 of this specification.

**13.4** The vendor shall perform the cables route survey prior to commencement of manufacturing and shall define the laying method in his proposal (laying on sea bottom, trenching or water jet). In case where the installation will be carried out by the purchaser, the cable route survey will be carried out by the purchaser.

**14. GUARANTEE**

**14.1** Cable/s shall be guaranteed against defective material, poor design and workmanship.

**14.2** The vendor shall guarantee the cables/s performance under specified condition.

**14.3** If any defect is discovered during the d.c. voltage test performed after the cable installation, the vendor shall be responsible for replacement of the cable/s free of charge.

Unless otherwise agreed between the cable vendor and the purchaser, the d.c. test voltage shall be equal to  $4U_0$  and shall be applied for fifteen minutes according to the recommendations of IEC 60502-2.

**APPENDICES**  
**APPENDIX A**  
**SUBMARINE CABLE - DATA SHEET**

The vendor shall complete and submit this data sheet for each cable together with his proposal.

1.	Name of project or plant		*
2.	Cable identification No.		*
3.	Operating voltage phase to phase (kV)		*
4.	Cable insulation voltage 3.6/6 kV, 6/10 kV, 12/20 kV, 18/30 kV		*
5.	System frequency (Hz)		*
6.	System grounding		*
7.	Total length of the cable (meter)		*
8.	Number of cable pieces (not more than 3)		
9.	Number of joints (not more than 2)		
10.	Length of cable pieces (m)		
11.	Gross weight of each cable piece (kg)		
12.	Turrets or baskets gross weight (kg)		
13.	Dimensions of the turrets, dia. & height (m)		
14.	Weight of cable in air (kg/m)		
15.	Weight of cable in water (kg/m)		
16.	Number of copper conductors in each cable		*
17.	Cross section of each power conductor (mm <sup>2</sup> )		*
18.	Conductor screen		
19.	Type of insulation		
20.	Insulation screen, non metallic layer		
21.	Metallic screen and thickness		
22.	Color of cores		
23.	Number of optical fiber cables		*
24.	Number of fibers in each optical fiber cable		*
25.	Type of optical fibers (single-mode or multimode)		
26.	Wave length of propagation (nm)		
27.	Protective separator of optical fibers		
28.	Optical fibers coating		
29.	Optical fibers hydrogen getter filling compound		
30.	Optical fibers protective tape/s		
31.	Optical fibers protective tube		
32.	Optical cables outer sheath		
33.	Interstice material used as cable filler		
34.	Binder tape/s on power cores and optical cables		
35.	Metallic sheath and thickness		
36.	Bedding		
37.	Number of wire armour and diameter		
38.	Number of armour layer/s		*
39.	Number and diameters of zinc wires		
40.	Thickness of the galvanized steel tape		
41.	Serving/oversheath		
42.	Lime wash coating if applicable		

\*by purchaser

(to be continued)

**APPENDIX A (to be continued)**

43.	AC resistance of copper conductors at 20°C (ohm/km)	
44.	DC resistance of copper conductors at 20°C (ohm/km)	
45.	Capacitance of copper conductors core to core micro F/km	
46.	Capacitance of copper conductors core to earth micro F/km	
47.	Capacitive current for each km of cable	
48.	Inductance of copper conductors (mH/km)	
49.	Permissible current rating of the cable in air at ISO condition	
50.	Permissible current rating of the cable in water at 20 °C	
51.	Short circuit capacity for one second and 0.5 second	
52.	Voltage drop per ampere per km	
53.	External diameter of the cable (mm)	
54.	Minimum recommended bending radius of the cable (m)	
55.	Maximum tensile strength of the cable	
56.	Accessories, their gross weight and packing size	Attach list
57.	Special tools for inspection and/or maintenance, if any	Attach list
58.	Deviations from this specification if any	Attach list
59.	Proposal for transportation and installation	Attach

**\*by purchaser**